ENABELING WEB-BASED INTERACTIVE HPC FOR RHINOLOGY

2020-12-09 I CHRISTIAN WITZLER (C.WITZLER@FZ-JUELICH.DE), ALICE GROSCH (A.GROSCH@FZ-JUELICH.DE),
JENS H. GÖBBERT (J.GOEBBERT@FZ-JUELICH.DE), TIM KREUZER (T.KREUZER@FZ-JUELICH.DE)

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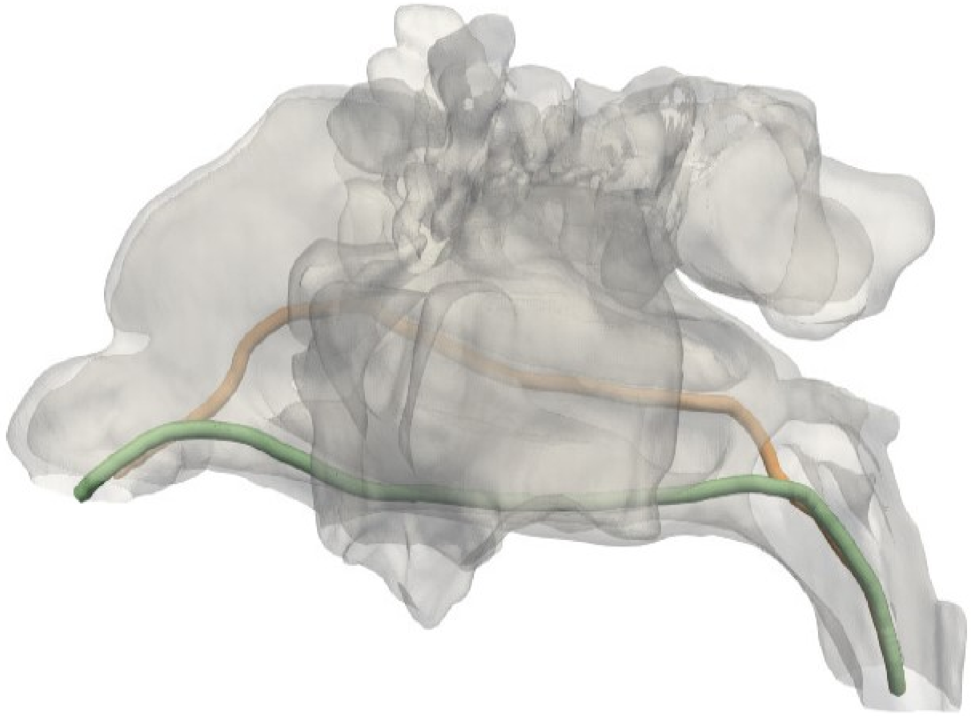
OUTLINE

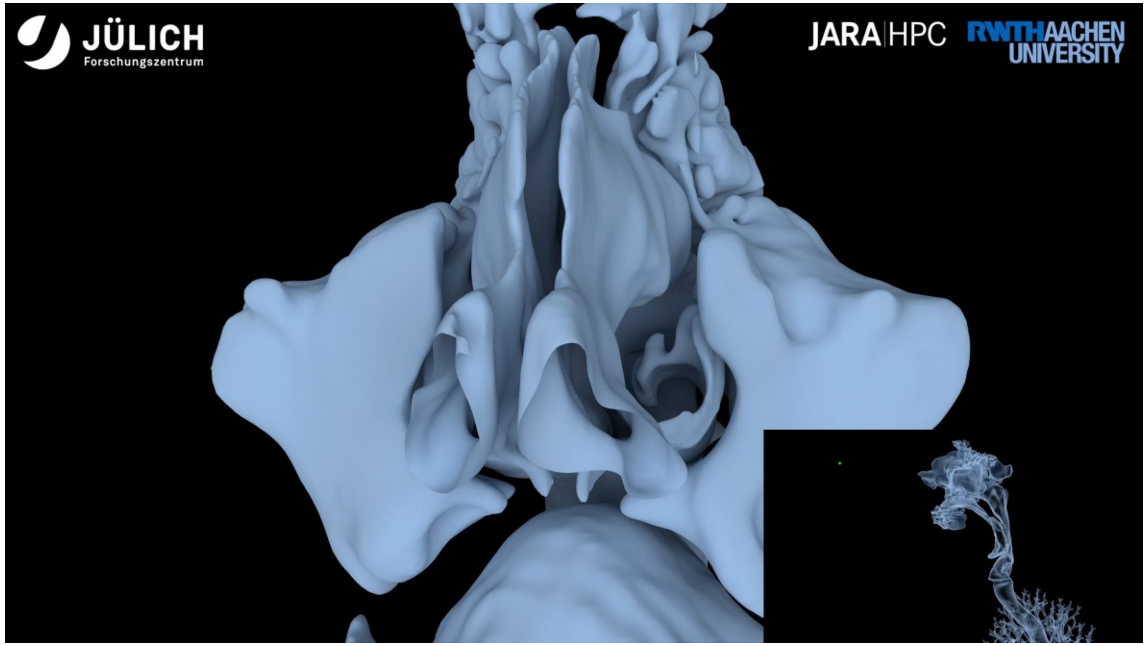
- Motivation
- Enabling interactive Supercomputing
  - Jupyter, Jupyter-JSC
  - Visualization in the browser
  - Security
- Dashboard for Rhinology
  - Development
  - Workflow management
  - Demonstration



MOTIVATION

Why do we need HPC for interactive visualization?

- Highly resolved direct numerical simulations (DNS) are essential for more insights into detailed flow properties
  - This results in extremely large data sets
  - Download can easily become impossible



DNS results must be visualized on site!

MOTIVATION

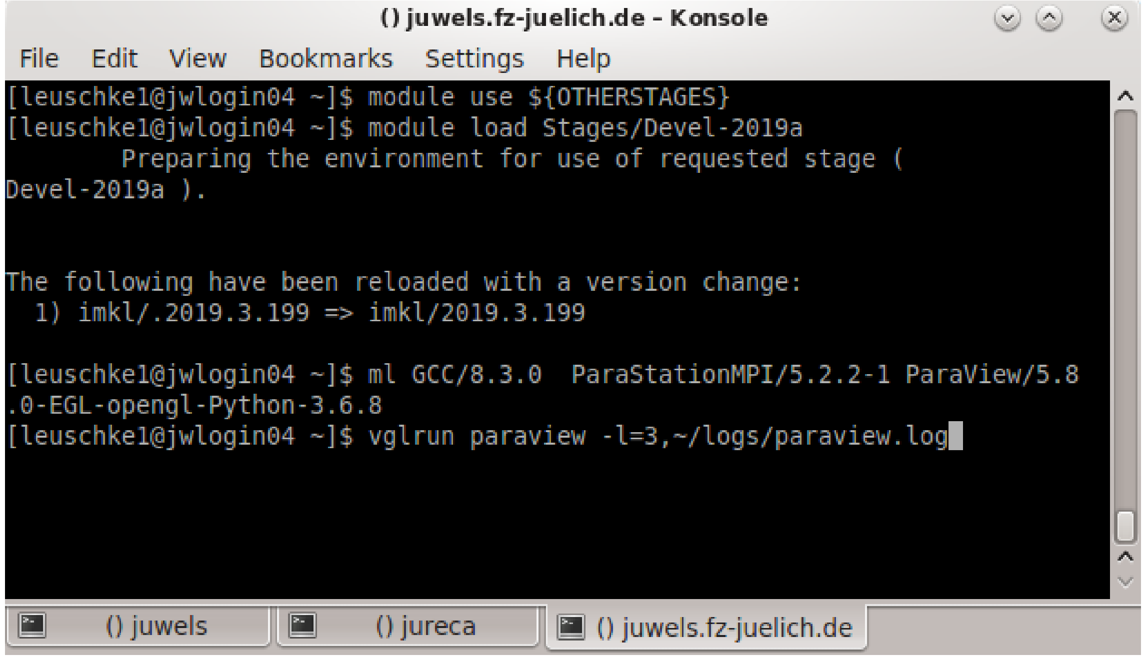
HPC at JSC

- JUWELS booster
    - November 2020
    - #7 in top 500
    - 479TB main memory
    - 71 Petaflops/s
    - 44,928 CPU cores
    - 12,939,264 CUDA cores

MOTIVATION

How we access HPC normaly?

- Normal access is via the command line
- For interactive visualization this means
  - Sign in using your ssh key
  - Start a vncserver
  - Forward the port
  - Connect a vncviewer
  - Start a visualization tool

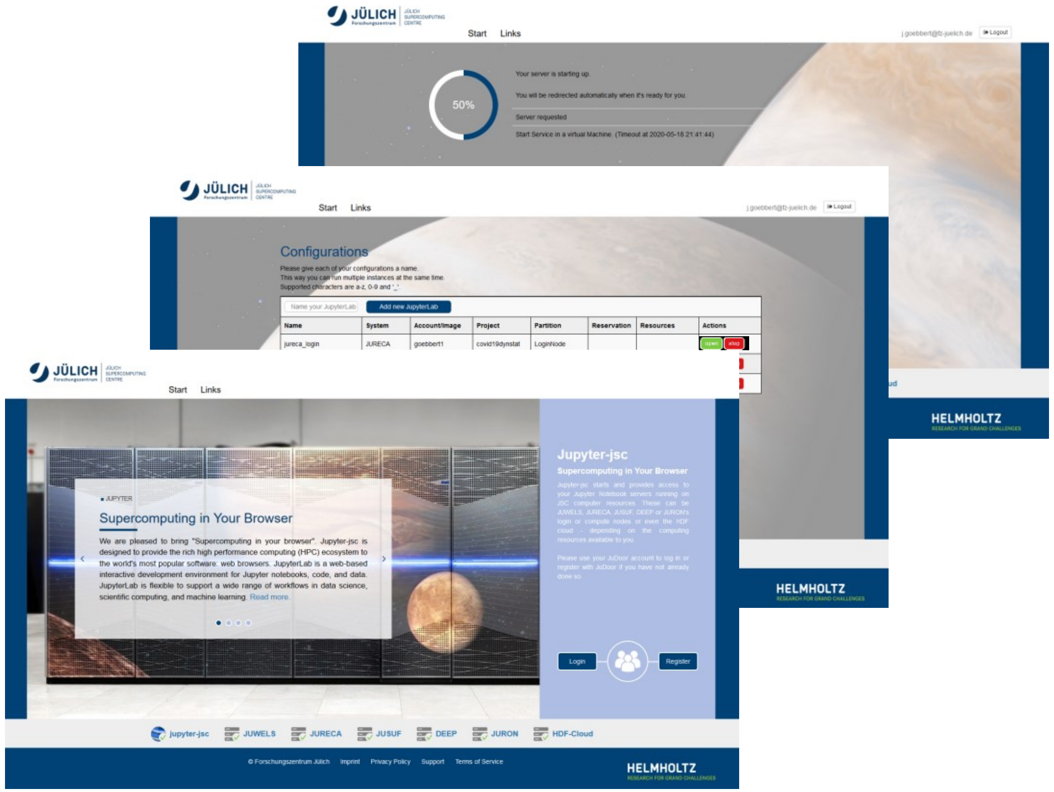


INTERACTIVE SUPERCOMPUTING

How Rhinodiagnost enabled HPC in the browser

"It is all about using and building a machinery **interface**
between computational researchers and data, supercomputers, laptops, cloud
and your thinking, your reasoning, your insides, your ideas about a problem."

Fernando Perez, Berkely Institute for Data Science
Founder of Project Jupyter

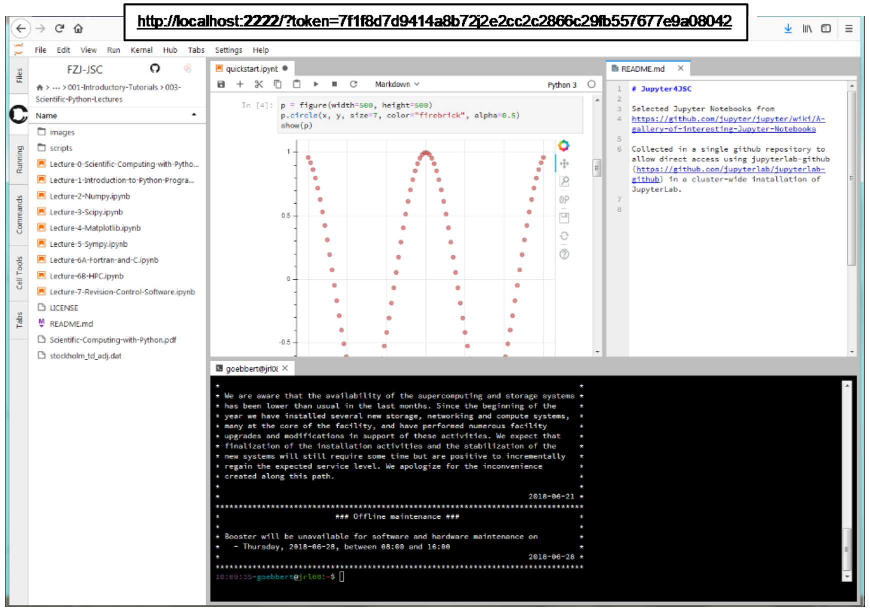


RHINO DIAGNOST
JÜLICH Forschungszentrum

INTERACTIVE SUPERCOMPUTING

Jupyter Notebooks

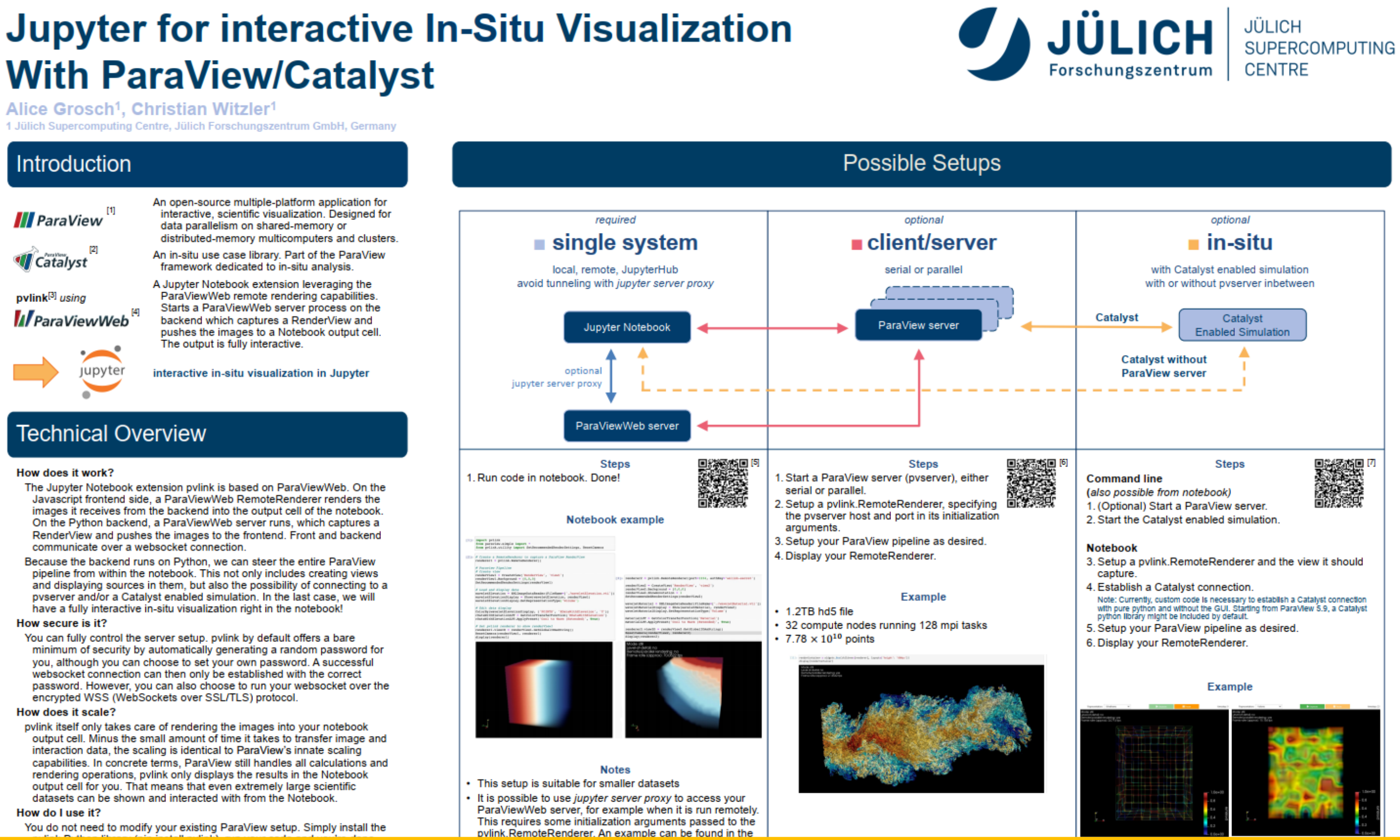
- Visualization in JupyterLab
  - Bokeh, Plotly, Matplotlib
  - Remote Desktop
- But:
  - Server-side rendering
  - 3D interactive visualization
  - Inside a Jupyter Notebook



We made this possible with PVlink

INTERACTIVE SUPERCOMPUTING

PVlink

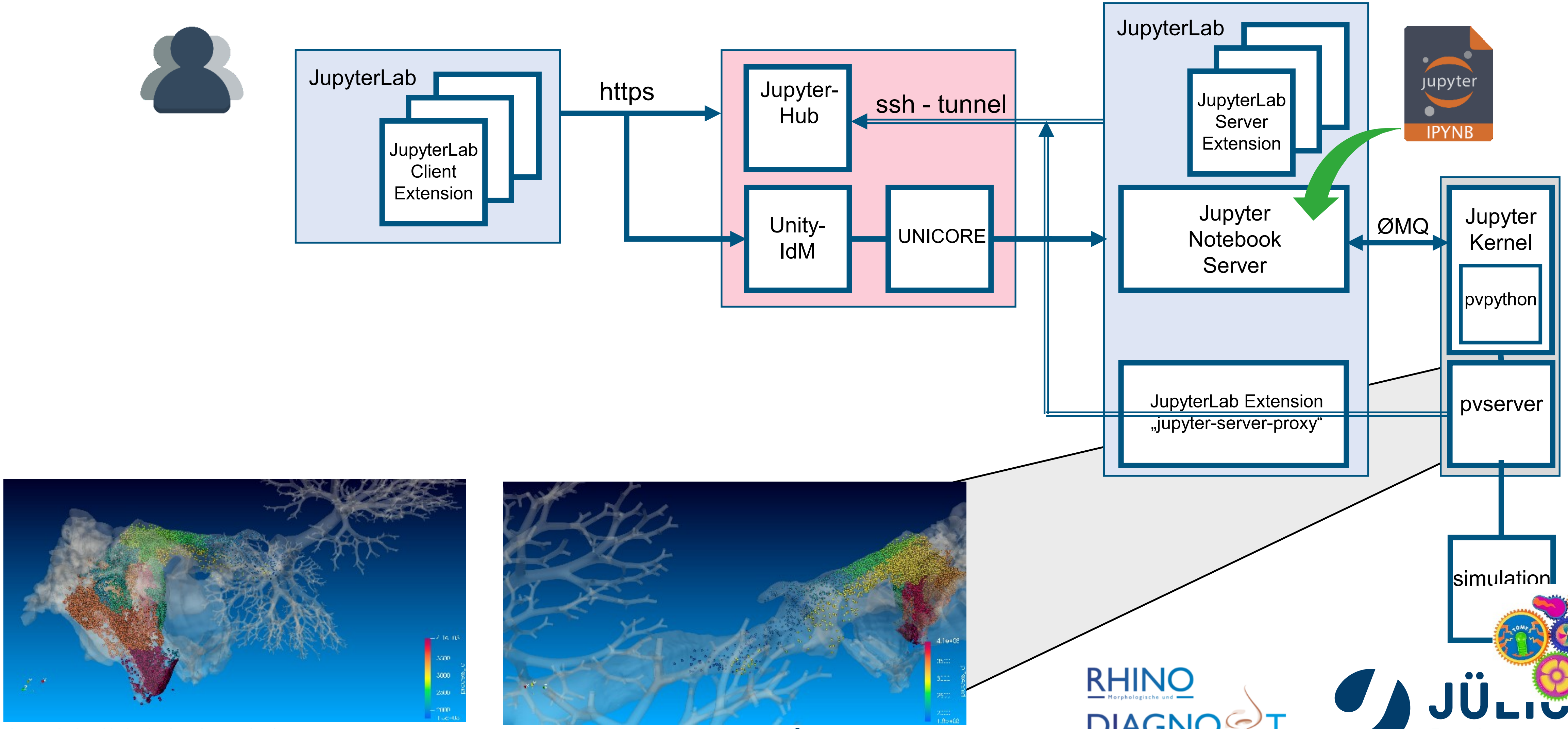


https://cfp.jupytercon.com/2020/schedule/presentation/123/jupyter-for-interactive-in-situ-visualization-with-paraviewcatalyst/

PVlink enables server-side 3D interactive visualization inside a Jupyter Notebook

INTERACTIVE SUPERCOMPUTING

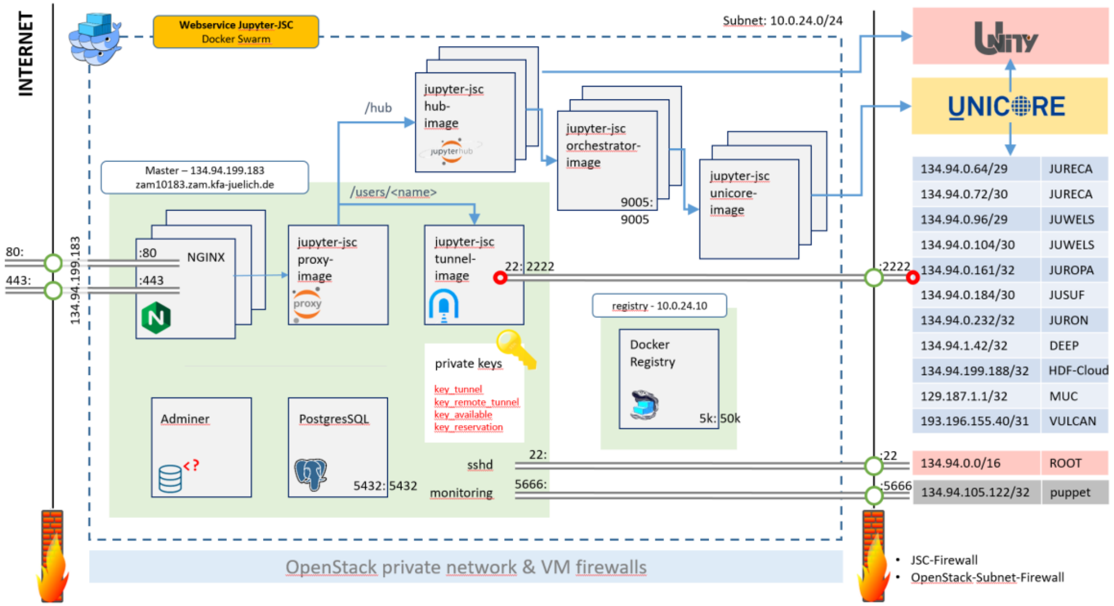
How Jupyter-JSC enabled HPC in the browser



INFORMATION SECURITY

Authentication, Authorization, Encryption, Anonymization

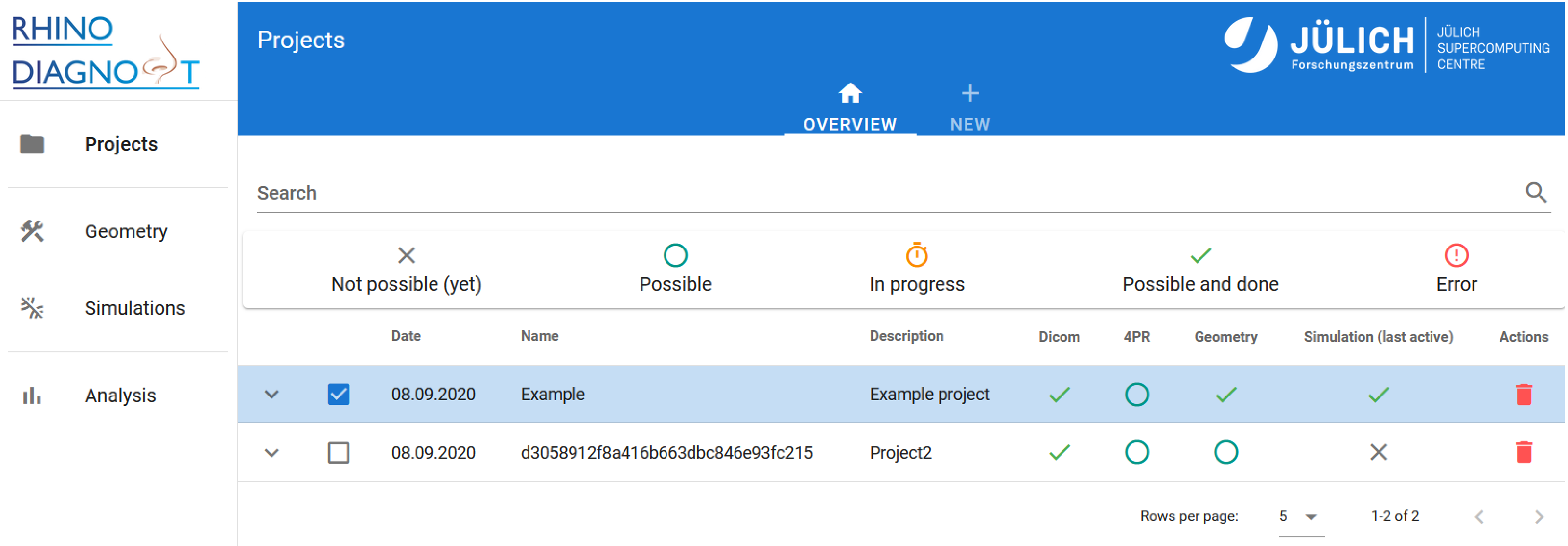
- Authentication – identity check
  - Registration & Login
  - Development of JupyterHub-AuthModule
- Authorization – permission check
  - Development of JupyterHub-Spawner
- Encrypted & Secured Communication
  - Outside JSC: HTTPS + session-tokens
  - Inside JSC: ssh-tunneling + password
- Anonymization
  - DICOM uploader



https://gitlab.version.fz-juelich.de/jupyter4jsc/j4j_extras/dicom-upload

DASHBOARD

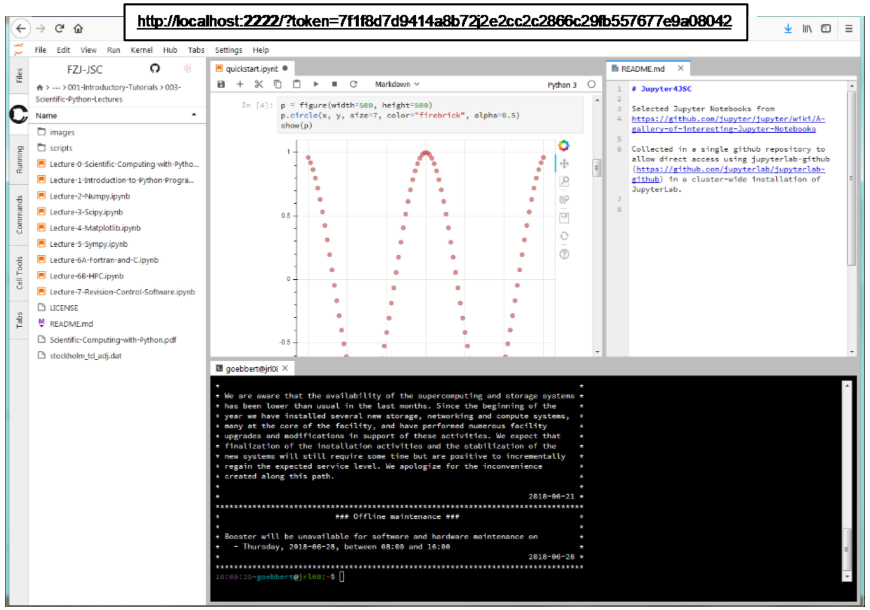
Rhinodiagnost UI for HPC workflows



DASHBOARD

Development - Design decisions

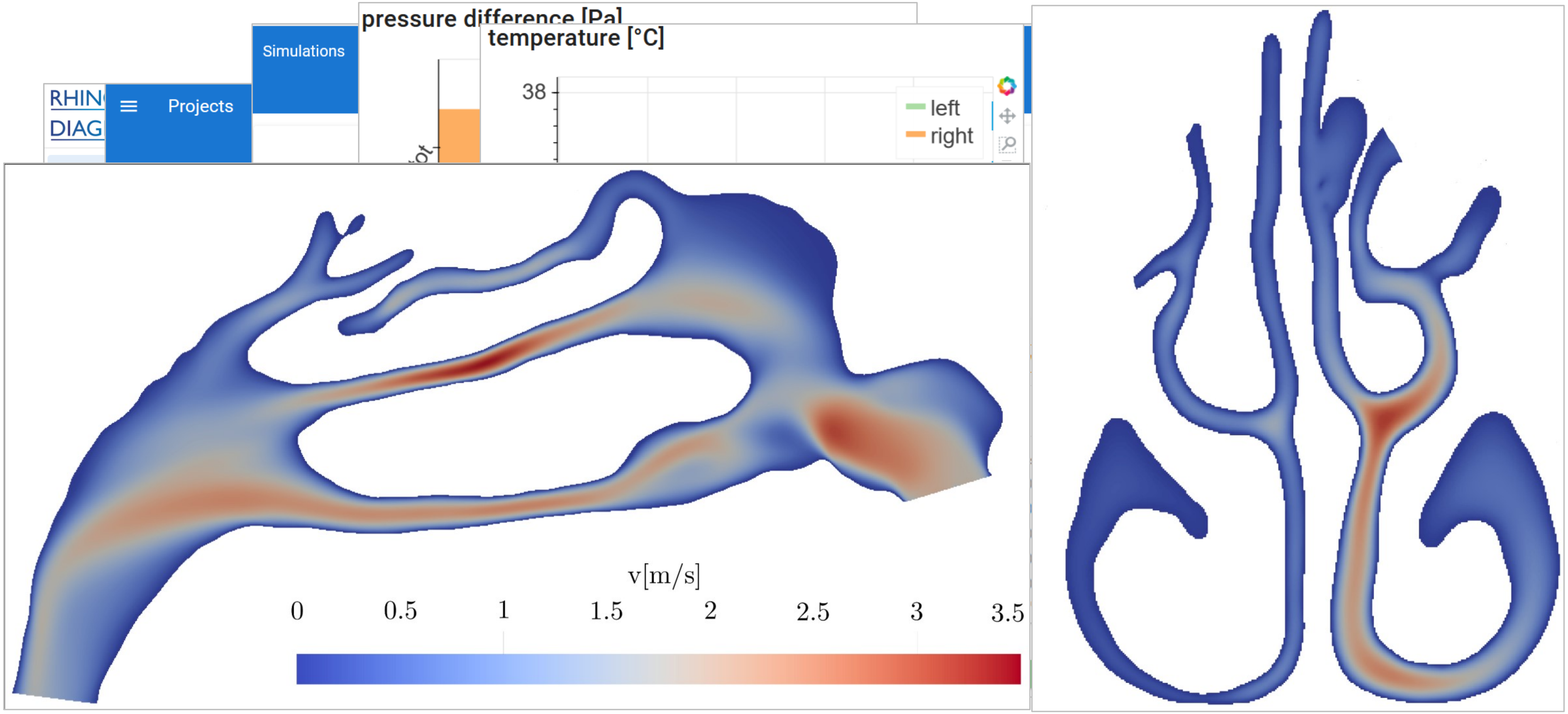
- Jupyter-JSC is backbone
- Programming language - Python
  - Secure
- Dashboard with Jupyter
  - Distributed & supported
  - Widely used for data analysis
  - Intuitive
  - Well defined functionality
  - Own language for all components
  - Open source



Dashboard development with „Voilà“

https://github.com/voila-dashboards/voila

DASHBOARD


pressure difference [Pa]
temperature [°C]
Simulations
Projects
38
left
right
v[m/s]
0
0.5
1
1.5
2
2.5
3
3.5

SUMMARY

- Motivation: highly resolved DNS must be visualized on site
- For non-domain experts, browser-based access is essential
  - Rhinodiagnost development
    - **JupyterLab through Jupyter-JSC**
- Server-side 3D interactive visualization is required
  - Rhinodiagnost development
    - **PVlink inlines access to ParaView server**
- Expressive, easy to understand, intuitive user interface for non-domain experts
  - Rhinodiagnost development
    - **Dashboard with volià based on Jupyter-JSC**

QUESTIONS?

Achnowledgments

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RHINO Morphologische und DIAGNOST funktionelle Präzisionsdiagnostik der Nase